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Box Patent Application
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Washington, District of Columbia 20231

Sir:

Please file the following enclosed patent application papers:

Applicant #1, Name: Charles andrew Lowry

Applicant #2, Name: _____

Title: Liquid purifying device

☒ Specification, Claims, and Abstract: Nr. of Sheets 23

☒ Declaration: Date Signed: July 19, 2000

☒ Drawing(s): Nr. of Sheets Enc.: Formal: _____ Informal: 20

☒ Small Entity Declaration of Inventor(s) ☐ SED of Non-Inventor / Assignee / Licensee

☐ Assignment enclosed with cover sheet and recordal fee; please record and return.

☒ Check for \$ 345.00 for.

☒ \$ 345.00 for filing fee (not more than three independent claims and twenty total claims are presented).

☐ \$ _____ additional if Assignment is enclosed for recordal.

☒ Information Disclosure Statement. Form PTO-1449, and listed references.

☒ Disclosure Document Program reference letter.

☐ Pursuant to 35 U.S.C. §119(e)(i), applicant(s) claim priority of Provisional Patent Application Ser. Nr. _____, filed _____.

☒ Return Receipt Postcard Addressed to Applicant #1.

☒ **Request Under MPEP § 707.07(j):** The undersigned, a pro se applicant, respectfully requests that if the Examiner finds patentable subject matter disclosed in this application, but feels that Applicant's present claims are not entirely suitable, the Examiner draft one or more allowable claims for applicant.

Very respectfully,

Charles andrew Lowry
Applicant #1 Signature

Applicant #2 Signature

770 East Vine St #B
Address (Send Correspondence Here)

Address

Murray UT 84107

Express Mail Label #

EK848542152US

; Date of Deposit 199 2000, 7, 21

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 Assistant Commissioner for Patents
 Washington, District of Columbia 20231

Fee Transmittal

First-Named Applicant Charles Andrew Lowry
 Title of Invention " Liquid purifying device "
 Total Payment Enclosed (From Calculation Below): \$ 345.00 ☐ Check ☒ Money Order

Sir

Enclosed is the following small entity filing fee for the above patent application:

Fee Code	Fee Description	Fee (\$)
214	Provisional Pat. Appn. Filing Fee	
201	Basic Utility Appn. Filing Fee	<u>\$345.00</u>
206	Basic Design Appn. Filing Fee	<u>0</u>
	Subtotal (1)	<u>0</u>
203	Total Claims: _____ - 20 = _____; X _____ (fee for each claim over 20) =	<u>0</u>
202	Tot. Indep. Claims _____ - 3 = _____; X _____ (fee for each indep. claim over 3) =	<u>0</u>
	Subtotal (2)	<u>0</u>

Total Payment Enclosed [Sum of Subtotals (1) and (2)]

Very respectfully,

Charles Andrew Lowry
 Signature of First-Named Applicant

Charles Andrew Lowry
 Print Name of First-Named Applicant

770 East Vine St. #B
 Address

St. Murray, UT 84107

In the United States Patent and Trademark Office

First/Sole Applicant: Charles Andrew Lowry
Joint/Second Applicant: _____
Title: "Liquid purifying device"

Small Entity Declaration—Independent Inventor(s)

As a below-named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35 United States Code, to the Patent and Trademark Office with regard to my above-identified invention described in the specification filed herewith. I have not assigned, granted, conveyed, or licensed—and am under no obligation under any contract or law to assign, grant, convey, or license—any rights in the invention to either (a) any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or (b) any concern which would not qualify as either (i) a small business concern under 37 CFR 1.9(d) or (ii) a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed—or am under an obligation under contract or law to assign, grant, convey, or license—any rights in the invention is listed below.

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☐ Any applicable person, concern, or organization is listed below*

Full Name: _____

Address: _____

I acknowledge a duty to file, in the above application for patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Char Andr Lowry
Signature of Sole/First Inventor

Charles Andrew Lowry
Print Name of Sole/First Inventor

July 19, 2000
Date of Signature

Signature of Joint/Second Inventor

Print Name of Joint/Second Inventor

Date of Signature

*Note: A separate Small Entity Statement is required from any listed entity

Patent Application of

Charles A. Lowry

for

LIQUID PURIFYING DEVICE

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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION.

The present invention and Patent Office Disclosure 472958 relates to a device for purifying liquids, and particularly relates to such a liquid purifying device utilizing the process of distillation/evaporation of volatile contaminants contained within a liquid to separate and remove such volatile contaminants from the contaminated liquid, and more particularly relates to such a device that utilizes a distillation/evaporation chamber which is mounted in place of or complementing the standard factory liquid filtering system.

2. DESCRIPTION OF THE PRIOR ART.

There presently exist a number of distillation-type liquid separation and reclamation devices for distillation/evaporation and removal of volatile contaminants from contaminated liquid. Most of these units are utilize what is called the thin-film evaporation process, wherein the oil is passed over a heated flat horizontal surface (evaporation plate), the theory being that the heat will cause the oil to flow to such a "thin

film” on the flat horizontal surface that volatile contaminants having a boiling point lower than that of the temperature of the evaporation plate will be evaporated, followed by a collection of the “purified” oil following contaminant evaporation. In addition, most of these thin-film evaporation-type distillation units incorporate a separate heating element
25 (generally electric) for maintaining the evaporation plate at the desired temperature. Typical of these units are shown in U.S. Patent Nos. 1,718,800, 2,472,717, and 4,006,084.

One of the problems with these prior art thin-film is that an electric heating element in the general vicinity of volatile contaminants and engine fuel creates a
30 potentially explosive environment. Another problem with prior art thin-film is that they are complicated and expensive to manufacture and service.

Additionally, most of these units require external mounting equipment and a convenient location for the placement of these devices. Oil distillation/evaporation units of this type are shown in U.S. Pat. Nos. 1,718,800, 2,472,717, 2,839,196, 3,198,104,
35 3,756,412, 4,006,084, 4,115,201, 4,189,351, 4,146,475, 4,289,583, 4,443,334, 4,349,438, 4,354,946, 4,369,110, 4,717,474, 4,830,745, 4,943,352, 5,242,034, 5,322,596; 5,630,912, 5,630,912, and applicants own U.S. Patents Nos. 5,824,211 and 5,776,315. All these patents disclose liquid purifying device designs which are mounted remotely from the source of the liquid. None of the prior art utilizes an existing filtration system to effect a
40 simple and effective liquid supply and mounting system for the liquid purifying device such as the system illustrated in this patent application.

There remains a need for an efficient evaporation apparatus that is small enough for use in a wide variety of applications while not being limited to the conventional means of liquid supply and liquid purifying device placement and mounting. However, at the time the present liquid purifying device was made, it was not obvious to those of ordinary skill in the art how those needs could be fulfilled, in view of the prior art as a whole.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a device for removing volatile contaminants from liquid that utilizes heat from the liquid to effect vaporization of the contaminants, rather than a separate heating element.

It is further object of the present invention to provide such a device that is small and compact, and conveniently fastens to existing liquid filter mounts.

SUMMARY OF THE INVENTION

The liquid purifying device (10) of the present invention is utilized for separating and removing volatile contaminants from liquids. In one embodiment, the device incorporates a self-contained particle filter (32) for filtering particles from the contaminated liquid. The liquid purifying device (10) itself comprises a distillation/evaporation chamber positioned essentially between the liquid source and the particle filter, and receives contaminated liquid that has been filtered by the filter media

(20). The filtered contaminated liquid is passed through the liquid metering orifice (26), whereupon the oil enters the distillation/evaporation chamber (22). Upon entering the distillation/evaporation chamber (22) the metered liquid spreads in a thin film, thereby effecting the distillation/evaporation process.

Heat for distillation/evaporation of the volatile contaminants from the liquid acting directly within the distillation/evaporation chamber (22) is provided by the heated liquid itself, without the necessity of a separate heating element to maintain the vaporization temperature of the distillation/evaporation chamber.

This distillation/evaporation process is based on the well known principles of the thin-film evaporation process, wherein a liquid is spread into a thin film and heated, thus allowing trapped volatile elements such as water, gasoline, trapped gases, etcetera, within the liquid to be evaporated and vented outside the liquid purifying device.

This liquid purifying device is typically used in a full-flow filter capacity with an internal combustion engine, whereby a small amount of contaminated engine oil is tapped from the normal oil flow through the filter and processed through the liquid purifying device, whereupon the volatile contaminants are vaporized, separated, and removed from the oil. The processed lubricating oil is then returned to the engine oil pan through purified liquid exit (24). The liquid to be purified communicates to the filter through a plurality of liquid filter communicating conduits (12) such that certain conduits allow liquid to flow to the filter and certain other conduits allow liquid to return to the source with little or no impedance in overall liquid flow. This liquid purifying device effectively

utilizes the existing liquid filter mounting system to facilitate its own mounting and
85 provide a convenient source of liquid.

In other application, the particle filter may or may not be used. Rather,
contaminated liquid-hydraulic liquid, machining oil, cooking oil, heating/cooling liquid,
etc. – with or without pre-heating – may be pumped directly into the
distillation/evaporation chamber for evaporation, distillation, and removal of volatile
90 contaminants therefrom, the processed liquid then being returned to the mechanism in
which it is used.

A first feature of this liquid purifying device is the improved utilization of space
by the use of the existing liquid filter mounting system. This utilization brings the
95 benefits of a compact installation with a direct liquid source and convenient placement
with minimum difficulty of installation and maintenance. Another benefit of this design
is the efficient use of the heat inherent to most liquid sources to heat the evaporation
chamber evenly and effectively without the need of any additional heat source, which
eliminates the need for potentially dangerous heating elements while improving
100 efficiency and reducing manufacturing costs.

Thus it is understood that a primary object of this liquid purifying device is to
advance the art of liquid purifying by providing a device with is easily and conveniently
mounted, simple to maintained, safer and more reliable operation, and is useful in a much
greater range of applications.

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These and other important objects, features and advantages of this liquid purifying device will become apparent as this description proceeds.

110

This liquid purifying device accordingly comprises the features of construction, combination of elements and arrangement of parts that will be exemplified in the construction hereinafter set forth, and the scope of this liquid purifying device will be indicated in the claims.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other objects of this liquid purifying device will appear in the following description and appended claims, reference being made to FIGS. 1-20 forming a part of the specification wherein like reference characters designate corresponding parts.

120

FIG. 1 is a vertical sectional view of the liquid purifying device of the present invention including the particulate filter.

FIG. 2 is a top plan view of a first embodiment of the liquid purifying device.

FIG. 3 is a bottom plan view of a first embodiment of the liquid purifying device.

FIG. 4 is a horizontal sectional view of a first embodiment of the liquid purifying device,

125

said view taken in the direction of arrows 1--1 in FIG 1.

FIG. 17 is a top plan view of a sixth embodiment of the liquid purifying device.

FIG. 19 is a horizontal sectional view of a sixth embodiment of the liquid purifying device, said view being taken along line 4--4 in FIG 16.

155

10	Liquid purifying device.
12	Liquid filter communicating conduits.
14	Liquid refiner to liquid source attachment means.
16	Liquid seals.
18	Distillation/evaporation chamber lid.
20	Vapor vent.
22	Distillation/evaporation chamber.
24	Refined liquid exit.
26	Liquid metering orifice.
28	Liquid diverting obstruction.

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32 Liquid filter.

34 Liquid source.

36 Liquid filter element.

38 Distillation/evaporation chamber lid attachment means.

40 Filter to liquid purifying device attachment means.

170

DESCRIPTION OF SPECIFIC EMBODIMENTS

175 The liquid purifying device of the present invention has application in many environments. For example, the device may be used to supplement factory filter systems in internal combustion engines in both mobile and stationary applications. It is also contemplated that the present liquid purifying device will have application in hydraulic systems, and in industrial applications wherever hydraulic liquid (oil), cutting (machining) oil, drilling liquid, cooking oil, cleaning liquids, cooling/heating liquids, etc. are used. For purposes of description and explanation of the concept of the liquid purifying device, however, and without limiting the concept or application of the 180 invention, the liquid purifying device will be described in an application of an oil-lubricated internal combustion engine.

185 Turning now to the drawings, and initially to Fig. 1, the liquid purifying device is shown generally illustrated by the numeral 10. The device includes a combination liquid purifying device to liquid source attachment means (14), filter to liquid purifying device attachment means (40), liquid communication conduits (12), and liquid filter (32). Oil from the engine flows through the liquid purifying device through the liquid communication conduits(s) (12) unimpeded to the liquid filter (32), which oil passes

through the liquid filter (32) in the customary manner and returns to the engine through
190 additional liquid communication conduit(s) (12) allowing the liquid purifying device to
be mounted in-between the engine and the conventional oil filter while retaining the
function of the conventional filter with the added capabilities of volatile contaminate
removal.

The liquid refining device 10 includes a contaminated oil metering orifice (26) for
195 conducting oil under pressure from the engine oil pump (not shown) to the
distillation/evaporation chamber while simultaneously moderating the oil delivery rate to
between 0.5 and 20 gallons per hour, although other flow rates are within the scope of
this liquid purifying device. The styles of metering orifice and oil filters used in this oil
refining device are well known and in common use.

200 The distillation/evaporation chamber is located in-between the engine and filter
for a number of reasons: (1) simplicity; (2) efficient use of space; (3) to maintain the oil
at the proper temperature for contaminant evaporation; (4) minimization of oil piping and
connections. In a preferred embodiment of the present invention, a three micron
particulate filter is used for the filter media in order to optimize the filtration.

205 The specific apparatus for separating and removing the volatile contaminants from
the oil is the distillation/evaporation chamber (22). The distillation/evaporation is simply
a chamber of the proper shape and dimensions such as to promote the spreading of the oil
into a thin film, and including an oil metering orifice (26), a vapor vent (20), and a
purified oil exit (24). The distillation/evaporation chamber is enclosed by the

210 distillation/evaporation lid (18), which is secured by the distillation/evaporation lid attachment means (38). In the preferred embodiment as observed in Fig. 1, the distillation/evaporation chamber (22), oil metering orifice (26), purified oil exit (24), and vapor vent (20) may all be incorporated into a single housing. The simplicity of this design is one of its greatest strengths.

215 As can be seen by the accompanying figures, the proper shape and dimensions of the distillation/evaporation chamber may vary widely according to the desired flow rate and liquid to be purified. Fig. 1 illustrates one such shape and dimensions wherein the shape of the distillation/evaporation chamber is an annular ring with a height roughly equivalent to twice the width of the chamber. Included in most embodiments of the liquid purifying device and specifically in Fig. 4, there can be seen a liquid diverting obstruction (28) which redirects the oil flow along the length of the distillation/evaporation chamber to the purified oil exit.

220 Referring again to Fig. 1, it can be seen that purified liquid exit (24) communicates the purified out from the distillation/evaporation chamber (22) to a location outside the chamber (which in the case of installation on an internal combustion engine, the oil would be communicated to an oil return line which returns the oil to the engine). Additionally, it can also be seen that vapor vent (20) communicates vaporized contaminants from within the distillation/evaporation chamber (22) to a location outside the chamber.

230

OPERATION

In the first preferred embodiment as illustrated by Figs. 1 - 4, the oil to be processed passes unimpeded through the body of the liquid refining device to the filter through the liquid filter communication conduits (12), flows through liquid filter (32) in the customary manner, and most of the oil returns to the engine by way of the additional liquid filter communication conduit (12) located centrally to the filter.

Contaminated oil to be purified enters the distillation/evaporation chamber (22) at the liquid metering orifice (24). This contaminated oil is under pressure, and can come from the oil source (as shown in Fig. 20) or the conventional oil filter outlet.

The oil, upon entering the distillation/evaporation chamber (22) experiences a sudden pressure drops considerably (to ambient or atmospheric pressure), due of course, to the metering orifice. The sudden drop of pressure facilitates evaporation of volatile contaminants that have been emulsified in the oil during its lubrication function.

The oil, as it flows within the distillation/evaporation chamber (22) is controlled in its direction of flow by the liquid diverting obstruction (28) so as to maximize the length of travel of the oil within the distillation/evaporation chamber and thusly maximize the efficiency of volatile removal. Also, as the oil flows through the distillation/evaporation chamber (22), it flows in a thin-film, which effects the thin-film evaporation of the volatile contaminants from the oil. This thin-film evaporation process may be greatly enhanced by the heat contained within the oil itself as the engine reaches operating temperature.

Those skilled in the art will appreciate that the distillation/evaporation chamber need not be perfectly vertical while oil is being processed therethrough. This is because as the oil flows through the distillation/evaporation chamber, the natural vibrations inherent in most liquid sources, and in particular internal combustion engines, inputs physical forces into the flow of the oil resulting in a churning and lapping action of the oil within the distillation/evaporation chamber (22) which evenly coats the interior of the chamber with a thin film of oil, thereby causing increased efficiency in evaporation of the volatile contaminants from within the oil.

Once flowing, this oil flow will remain continuous and uninterrupted throughout the distillation/evaporation chamber, whereupon the oil exits the distillation/evaporation chamber by way of purified liquid exit (24) to be returned to the engine.

As can be appreciated, as these various volatile contaminants vaporize and are distilled from the initially contaminated oil, the accumulation of vapor requires a means of exhaust. Because of the fact that the distillation/evaporation chamber forms essentially a closed system, the pressure within the closed system, and therefore within the liquid channel (38) remains essentially constant. Therefore, as the various contaminants vaporize and expand, the vapor is forced through the vapor vent (20). In addition, in certain mobile and industrial applications, a negative pressure (a separate vacuum) can be used to withdraw the released vaporized contaminants from the evaporation chamber.

FIRST ALTERNATIVE EMBODIMENT

Figs. 5 - 8 illustrates a first alternative embodiment of the liquid purifying device.

The first alternative embodiment of Fig. 5 illustrates the use of an alternate means
275 of attachment of both the liquid purifying device to the source (engine) and of the filter to
the device by the use of an attachment means (40) which extents completely through the
filter housing through the liquid purifying device to the liquid source. Additionally, the
full flow of the oil to be purified is directed through the liquid purifying device so that all
oil is purified before being returned to use.

SECOND ALTERNATIVE EMBODIMENT

The second alternative embodiment of Fig. 9 illustrates the use of an extended
distillation/evaporation chamber, which extension extends longitudinally to the filter and
surrounds the filter. Within this extension is a spirally extending distillation/evaporation
285 chamber which effects a longer evaporation path for increased volatile removal
efficiency. Additionally, the full flow of the oil to be purified is directed through the
liquid purifying device so that all oil is purified before being returned to use.

THIRD ALTERNATIVE EMBODIMENT

290 The third alternative embodiment of Fig. 10 illustrates the use of an extended
distillation/evaporation chamber, which extension extends longitudinally to the filter and
surrounds the filter. Within this extension is a cascading and downwardly projecting
array of fins which effects a longer evaporation path for increased volatile removal

295 liquid purifying device so that all oil is purified before being returned to use.

FORTH ALTERNATIVE EMBODIMENT

Figs. 11 - 14 illustrates a second alternative embodiment of the liquid purifying device. The forth alternative embodiment of Fig. 11 illustrates the use of a liquid purifying device to source attachment means (14) which comprises a bolt which itself comprises a liquid flow conduit (14) for allowing the device to be offset-mounted. This means of mounting allows the device to be installed in otherwise space restricted areas. Additionally, the distillation/evaporation chamber is constructed in a non-annular fashion, but instead is grouped to one general location within the liquid purifying device, while the liquid conduits are themselves also grouped within the liquid purifying device as shown.

FIFTH ALTERNATIVE EMBODIMENT

The fifth alternative embodiment of Fig. 15 illustrates the use of a horizontally mounted liquid purifying device which incorporates the liquid metering orifice (26) and the vapor vent (20) in the uppermost location, while the purified liquid exit (24) is located in the lowermost location. No liquid diverting obstruction (28) is used with this embodiment so as to allow the oil to flow evenly and uniformly down all interior surfaces of this horizontally mounted embodiment.

SIXTH ALTERNATIVE EMBODIMENT

Figs. 16 - 19 illustrates a second alternative embodiment of the liquid purifying device. The sixth alternative embodiment of Fig. 16 illustrates the use of distillation/evaporation lid (16) which is engaged as part of the liquid purifying device by means of a press fit, thereby eliminating the need for additional lid attachment means.

320 Additionally, the distillation/evaporation chamber is constructed so as to facilitate installation by incorporating a plurality of vapor vents (20) and purified liquid exits (24). This allows the user to install the device without concern whether the vapor vent or liquid exit will be located in the proper orientation. The user ability to install the device and then select the appropriate vapor vent and liquid exit locations for proper operation will
325 greatly enhance the installation procedure.

SEVENTH ALTERNATIVE EMBODIMENT

The seventh alternative embodiment of Fig. 20 illustrates the construction of a liquid refining device which does not use a filter.

330

This liquid purifying device is clearly new and useful. Moreover, it was not obvious to those of ordinary skill in the art at the time it was made, in view of the prior art considered as a whole as required by law.

335

It will thus be seen that the objects set forth above, and those made apparent from the foregoing description, are efficiently attained and since certain changes may be made

in the above construction without departing from the scope of this liquid purifying device, it is intended that all matters contained in the foregoing construction or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

340

It is also to be understood that the following claims are intended to cover all of the generic and specific features of this liquid purifying device herein described, and all statements of the scope of this liquid purifying device which, as a matter of language, might be said to fall therebetween.

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345 **Claims: I claim:**

1. Apparatus for separating and removing volatile contaminants from a liquid,
 comprising:
 a distillation/evaporation chamber comprising at least one sidewall; and
 an attachment means for directly mounting the distillation/evaporation
 chamber to a liquid source.
2. Apparatus as set forth in claim 1, further comprising:
 an inlet to the distillation/evaporation chamber to allow flow of liquid into
 the distillation/evaporation chamber from a liquid source outside the
 distillation/evaporation chamber, said liquid outside the
 distillation/evaporation chamber having a pressure.
3. Apparatus as set forth in claim 2, further comprising;
 an outlet from the distillation/evaporation chamber for flow of liquid to
 outside the distillation/evaporation chamber.
4. Apparatus as set forth in claim 3, further comprising;
 a vent in the distillation/evaporation chamber to vent airborne
 contaminants therefrom.

5. Apparatus as set forth in claim 4, further comprising;
- a plurality of liquid communication channels located adjacent to the distillation/evaporation chamber for the transmission of liquid.

- 370 6. Apparatus as set forth in claim 5, further comprising;
- a filter adjacent to the distillation/evaporation chamber to remove particulate contaminants from the liquid.

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7. Apparatus for separating and removing volatile contaminants from a liquid, comprising:

375 a housing encompassing a chamber;
an inlet to the chamber to allow flow of liquid into the chamber from a
liquid source outside the chamber, said liquid outside the chamber having
a pressure;
an outlet from the chamber for flow of liquid to outside the
380 chamber;
a vent in the chamber to vent airborne contaminants therefrom; and
an attachment means for directly mounting the housing to a liquid source.

8. Apparatus as set forth in claim 7, further comprising;

385 a filter mounted to the housing to remove particulate contaminants from
liquid flowing into the chamber.

9. Apparatus as set forth in claim 8, further comprising;

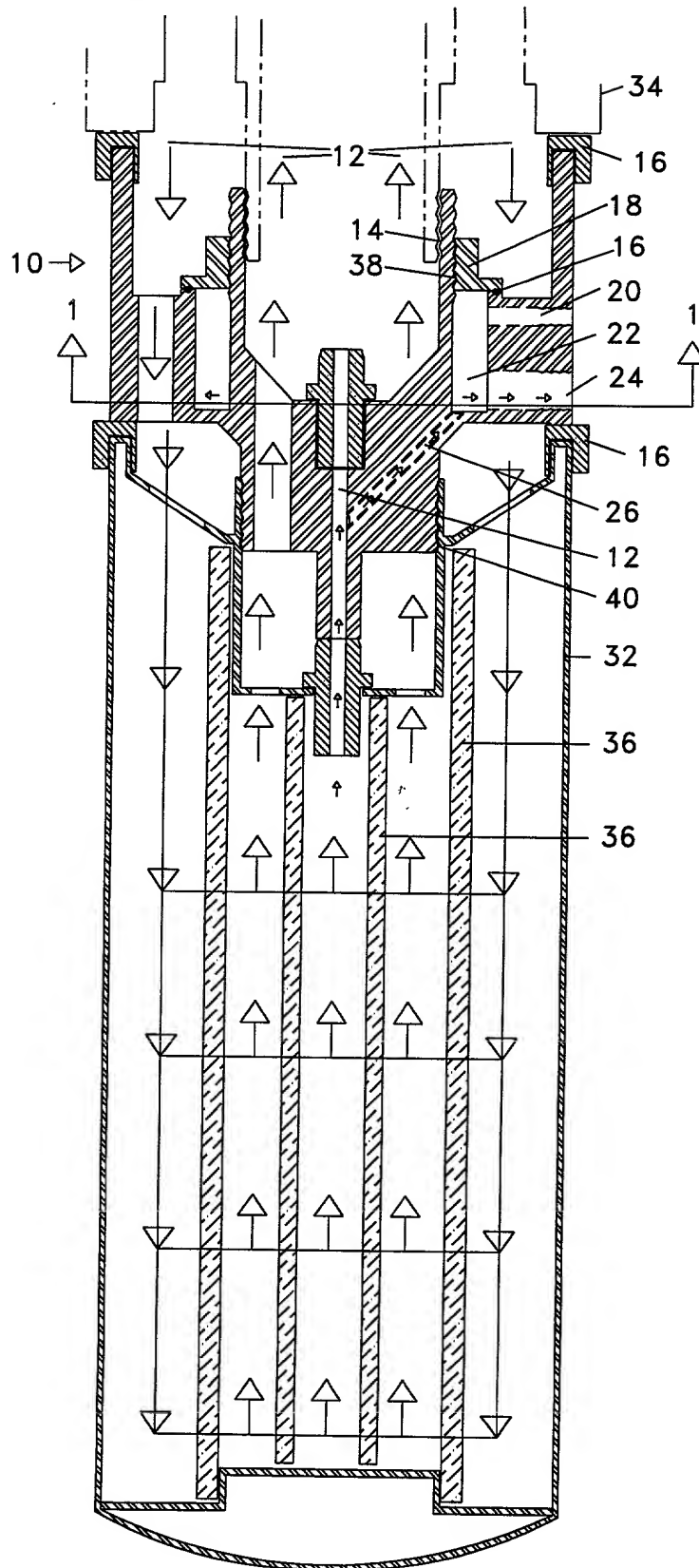
390 a plurality of liquid communication conduits extending through the
housing for the transmission of liquid to and from the filter.

- 395

A liquid purifying device for separation and removal of volatile contaminants

400

Fig 1



Variable	Mean	SD	Min	Max
Age	34.5	10.2	18	65
Gender	0.52	0.50	0	1
Marital status	0.68	0.48	0	1
Education	12.5	2.1	9	16
Income	15.2	3.5	10	25
Occupation	1.2	0.8	0	2
Health status	1.8	0.9	1	3
Stress level	2.5	1.2	1	4
Life satisfaction	3.2	1.5	1	5
Resilience	2.8	1.1	1	4
Optimism	3.5	1.3	1	5
Gratitude	3.8	1.4	1	5
Self-esteem	3.1	1.2	1	5
Empathy	3.4	1.3	1	5
Prosocial behavior	3.6	1.4	1	5
Altruism	3.7	1.5	1	5
Helping behavior	3.9	1.6	1	5
Volunteering	4.0	1.7	1	5
Charitable giving	4.1	1.8	1	5
Community involvement	4.2	1.9	1	5
Civic participation	4.3	2.0	1	5
Political engagement	4.4	2.1	1	5
Environmental activism	4.5	2.2	1	5
Social justice advocacy	4.6	2.3	1	5
Human rights support	4.7	2.4	1	5
Peacebuilding efforts	4.8	2.5	1	5
Conflict resolution	4.9	2.6	1	5
Non-violent resistance	5.0	2.7	1	5
Dialogue facilitation	5.1	2.8	1	5
Mediation services	5.2	2.9	1	5
Restorative justice	5.3	3.0	1	5
Reconciliation efforts	5.4	3.1	1	5
Truth and reconciliation	5.5	3.2	1	5
Justice reform	5.6	3.3	1	5
Legal aid provision	5.7	3.4	1	5
Pro bono services	5.8	3.5	1	5
Public defender support	5.9	3.6	1	5
Legal education	6.0	3.7	1	5
Law reform	6.1	3.8	1	5
Legal research	6.2	3.9	1	5
Policy analysis	6.3	4.0	1	5
Legislative advocacy	6.4	4.1	1	5
Regulatory reform	6.5	4.2	1	5
Government accountability	6.6	4.3	1	5
Transparency initiatives	6.7	4.4	1	5
Open government	6.8	4.5	1	5
Public participation	6.9	4.6	1	5
Citizen engagement	7.0	4.7	1	5
Participatory budgeting	7.1	4.8	1	5
Community planning	7.2	4.9	1	5
Urban development	7.3	5.0	1	5
Infrastructure improvement	7.4	5.1	1	5
Public works programs	7.5	5.2	1	5
Job creation initiatives	7.6	5.3	1	5
Small business support	7.7	5.4	1	5
Economic development	7.8	5.5	1	5
Entrepreneurship training	7.9	5.6	1	5
Financial literacy programs	8.0	5.7	1	5
Microfinance services	8.1	5.8	1	5
Savings group support	8.2	5.9	1	5
Insurance schemes	8.3	6.0	1	5
Risk management	8.4	6.1	1	5
Disaster preparedness	8.5	6.2	1	5
Emergency response	8.6	6.3	1	5
Humanitarian aid	8.7	6.4	1	5
Refugee support	8.8	6.5	1	5
Displacement assistance	8.9	6.6	1	5
Resettlement programs	9.0	6.7	1	5
Integration services	9.1	6.8	1	5
Cultural exchange	9.2	6.9	1	5
Language training	9.3	7.0	1	5
Skills development	9.4	7.1	1	5
Employment opportunities	9.5	7.2	1	5
Job matching services	9.6	7.3	1	5
Professional development	9.7	7.4	1	5
Leadership training	9.8	7.5	1	5
Management courses	9.9	7.6	1	5
Technical education	10.0	7.7	1	5
Vocational training	10.1	7.8	1	5
Apprenticeship programs	10.2	7.9	1	5
Entrepreneurship incubators	10.3	8.0	1	5
Business development	10.4	8.1	1	5
Market access	10.5	8.2	1	5
Export promotion	10.6	8.3	1	5
Trade facilitation	10.7			

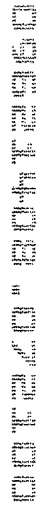


Fig 3

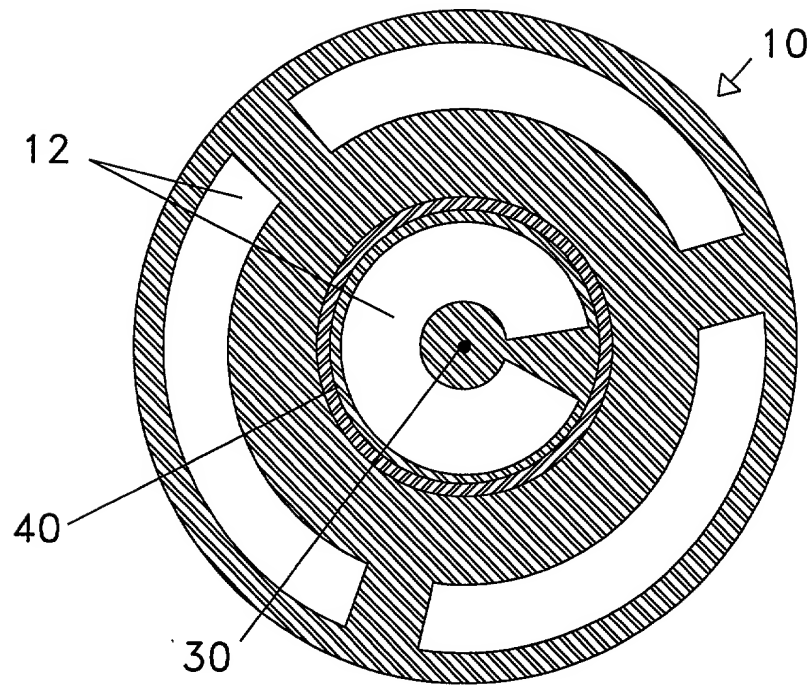
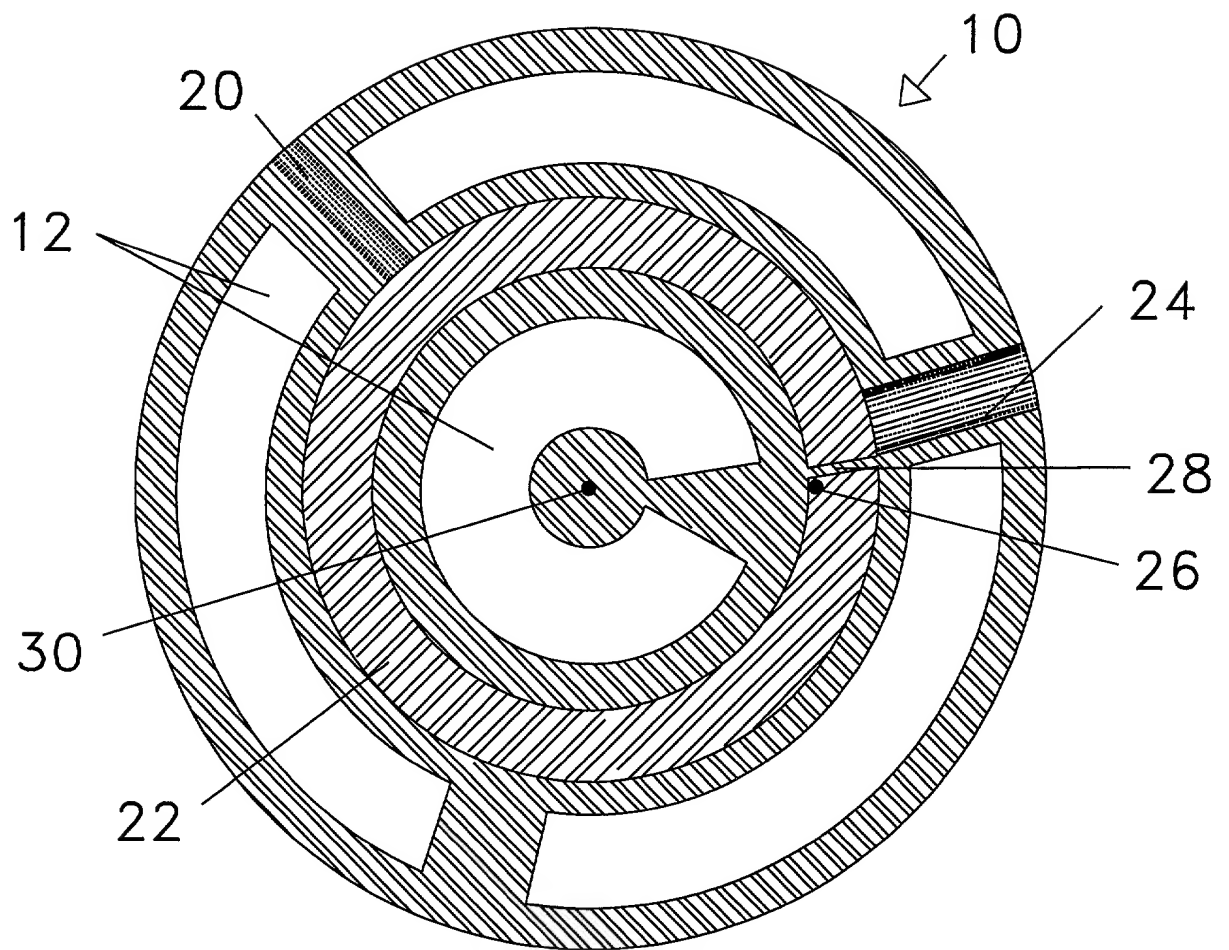


Fig 4



Variable	Mean	Standard deviation	Minimum	Maximum
Age	34.5	10.5	20	55
Gender	Male	Female		
Marital status	Married	Single		
Education	High school	College		
Occupation	Manager	Worker		
Income	\$10,000	\$20,000		
Health status	Good	Poor		
Exercise frequency	Weekly	Monthly		
Stress level	Low	High		
Sleep quality	Good	Poor		
Dietary habits	Healthy	Unhealthy		
Alcohol consumption	None	Occasional		
Tobacco use	Non-smoker	Smoker		
Family size	1-2	3-4		
Work hours	40-50	60+		
Commuting time	15-30	45+		
Home ownership	Owner	Renter		
Neighborhood safety	Safe	Unsafe		
Access to green spaces	Yes	No		
Proximity to public transport	Close	Far		
Local air quality	Good	Poor		
Local noise levels	Low	High		
Local crime rates	Low	High		
Local social services	Good	Poor		
Local cultural activities	Yes	No		
Local economic stability	Stable	Unstable		
Local political engagement	High	Low		
Local community cohesion	High	Low		
Local infrastructure quality	Good	Poor		
Local environmental quality	Good	Poor		
Local healthcare access	Good	Poor		
Local education quality	Good	Poor		
Local job opportunities	High	Low		
Local social inequality	Low	High		
Local social mobility	High	Low		
Local social capital	High	Low		
Local social trust	High	Low		
Local social cohesion	High	Low		
Local social support	High	Low		
Local social network	Large	Small		
Local social capital	High	Low		
Local social trust	High	Low		
Local social cohesion	High	Low		
Local social support	High	Low		
Local social network	Large	Small		
Local social capital	High	Low		
Local social trust	High	Low		
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Local social trust	High	Low		
Local social cohesion	High	Low		
Local social support	High	Low		
Local social network	Large	Small		
Local social capital	High	Low		
Local social trust	High	Low		
Local social cohesion	High	Low		
Local social support	High	Low		
Local social network	Large	Small		

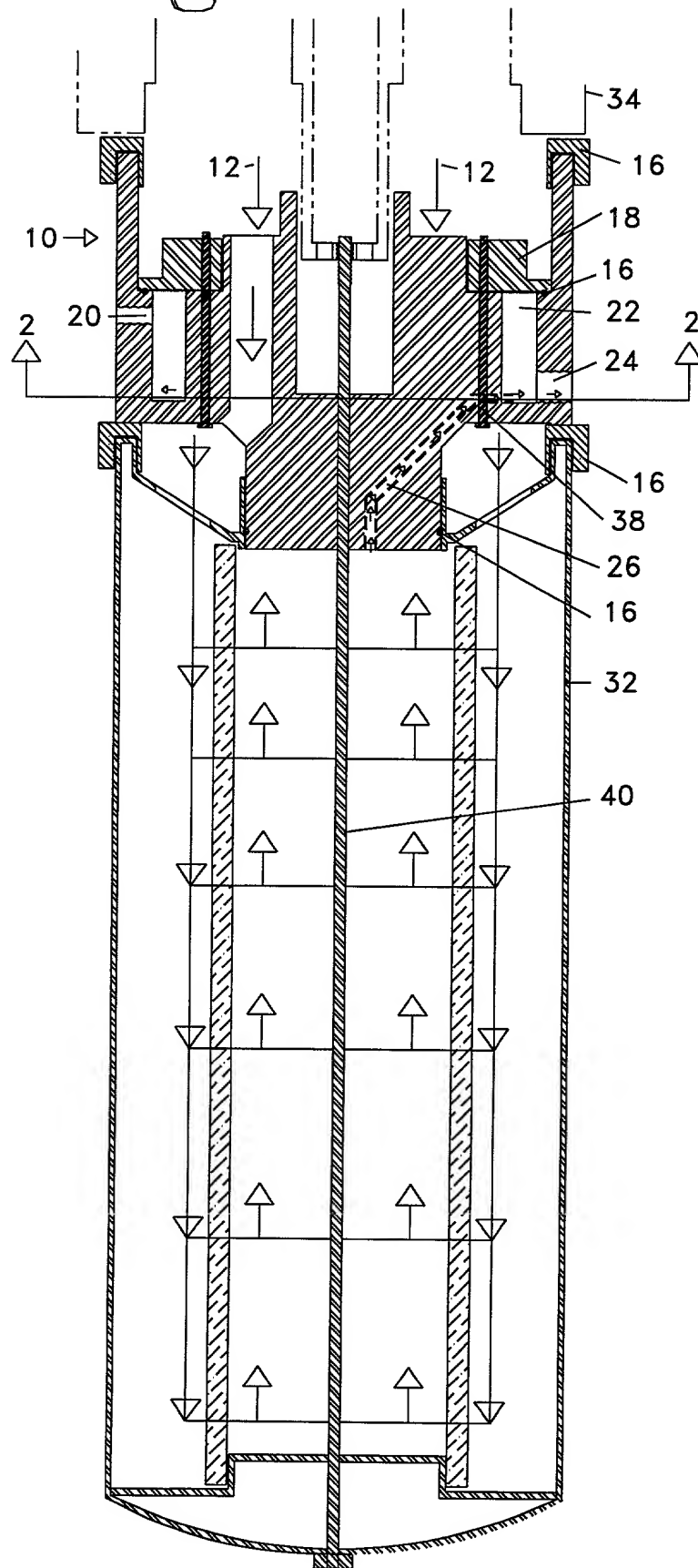


Fig 6

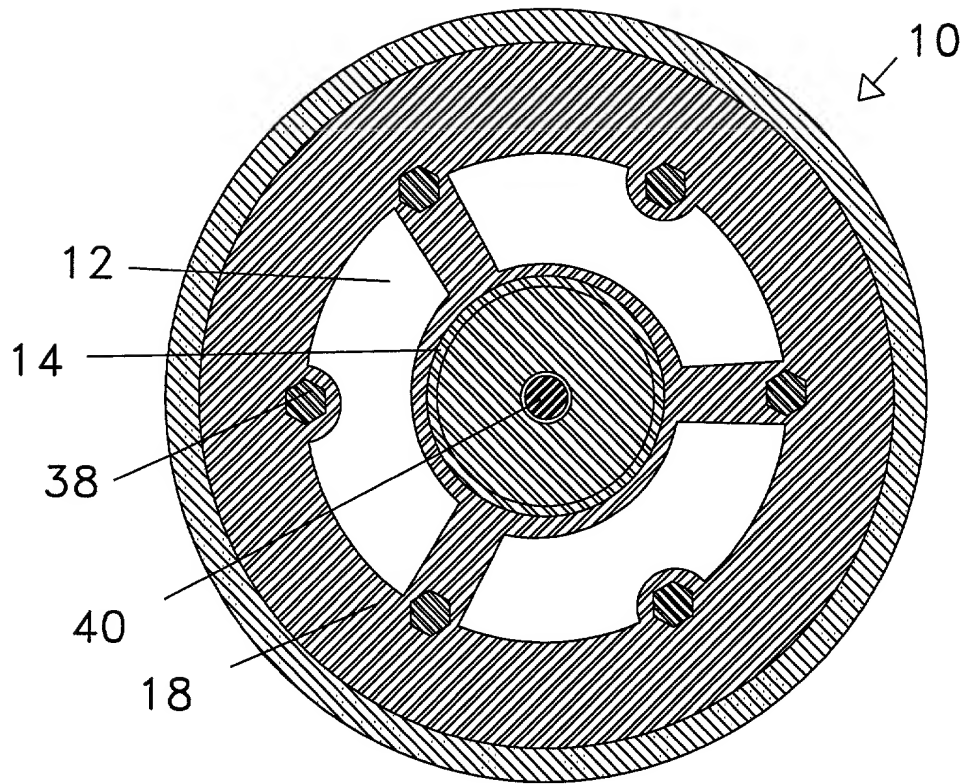


Fig 7

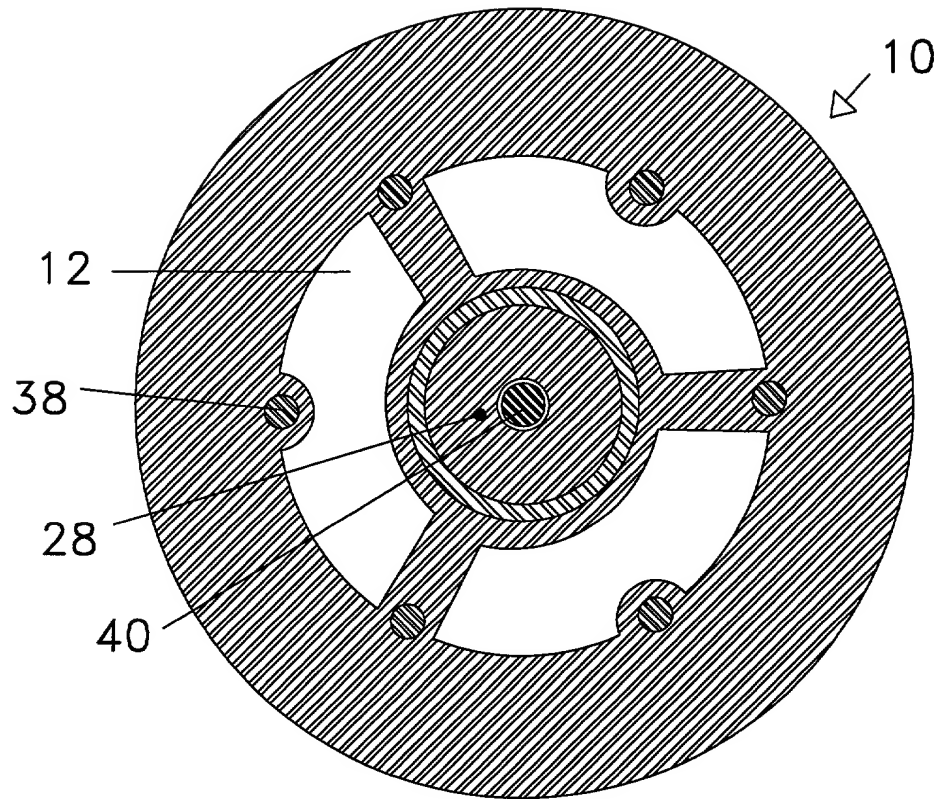


Fig 8

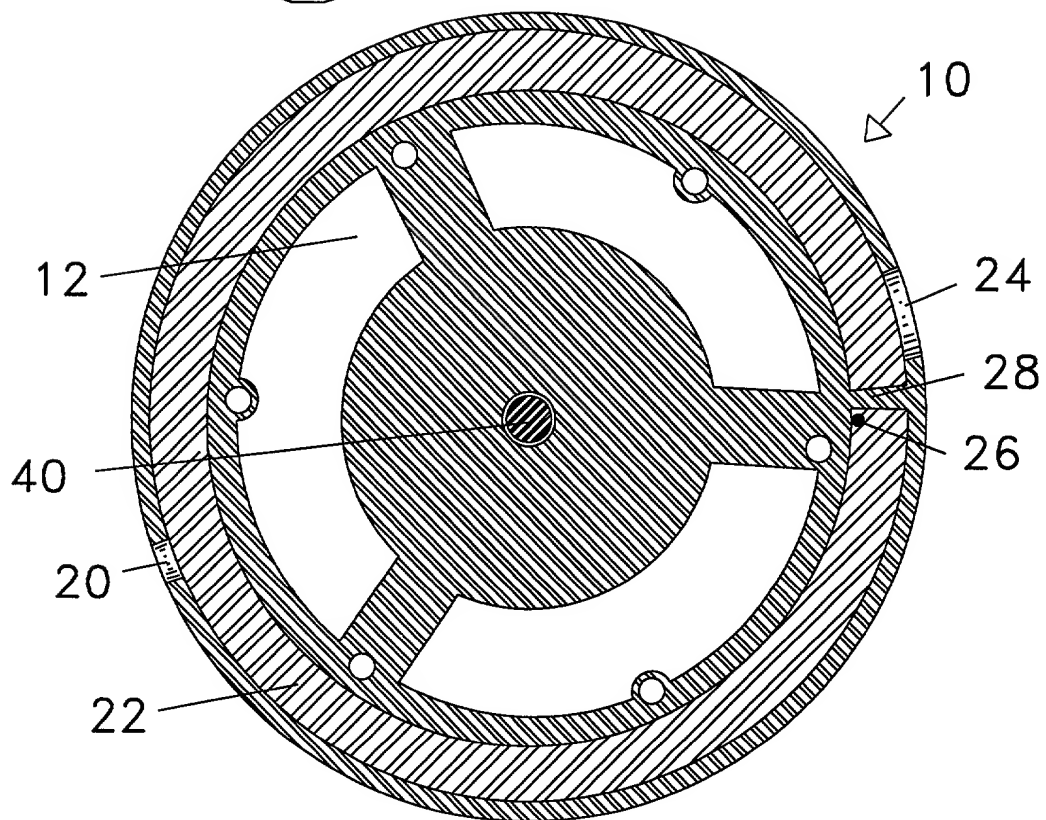


Fig 9

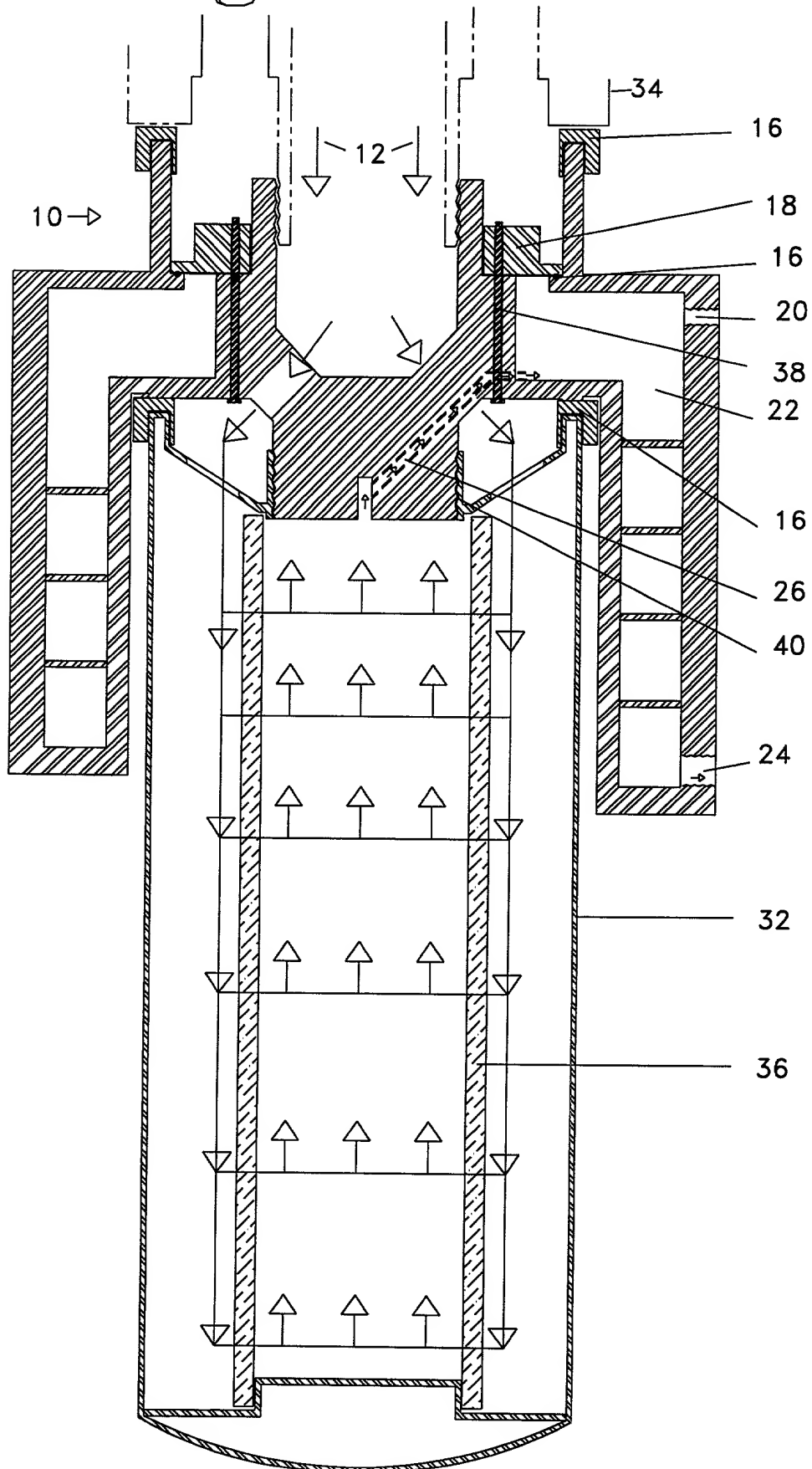


Fig 10

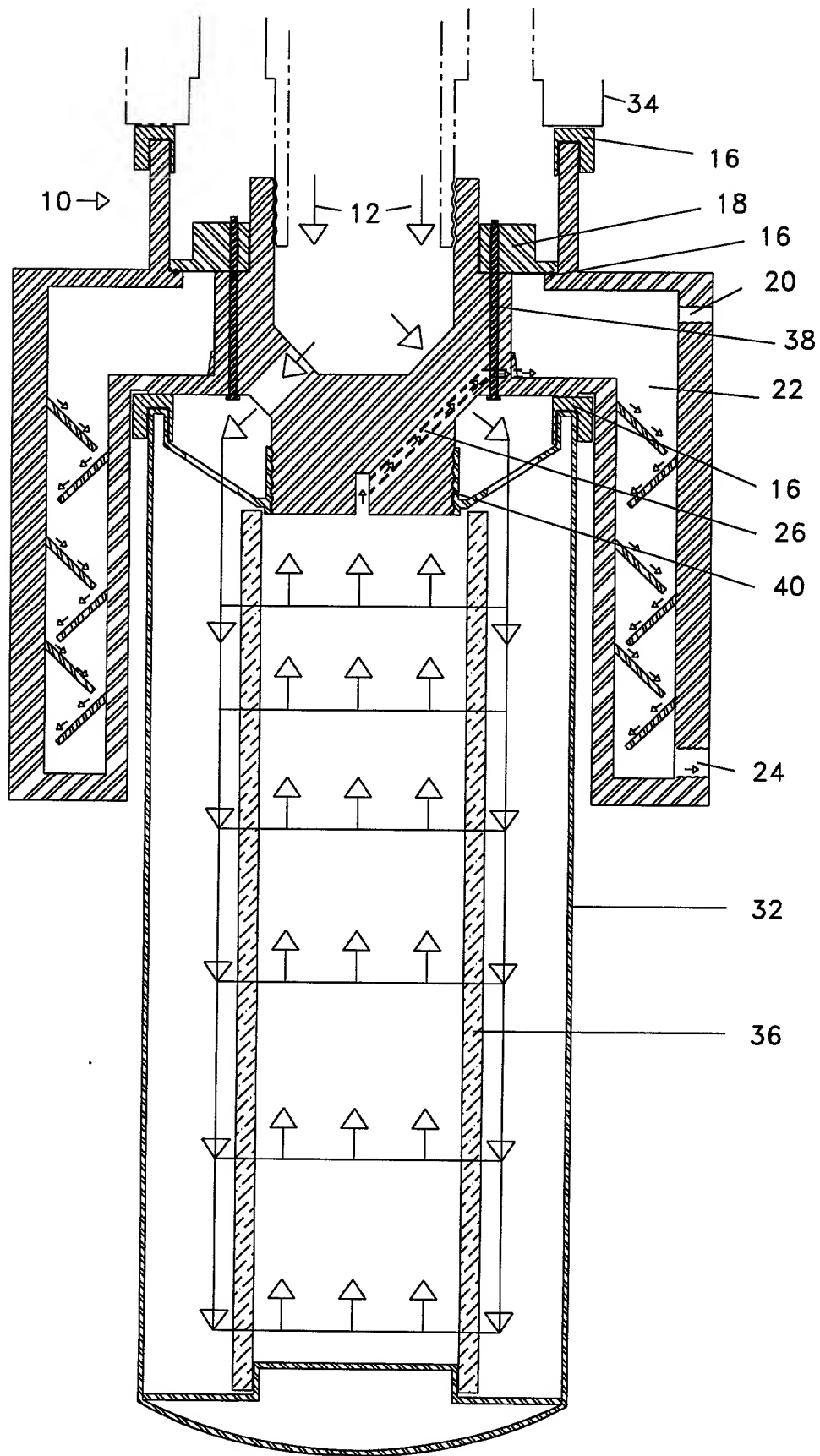
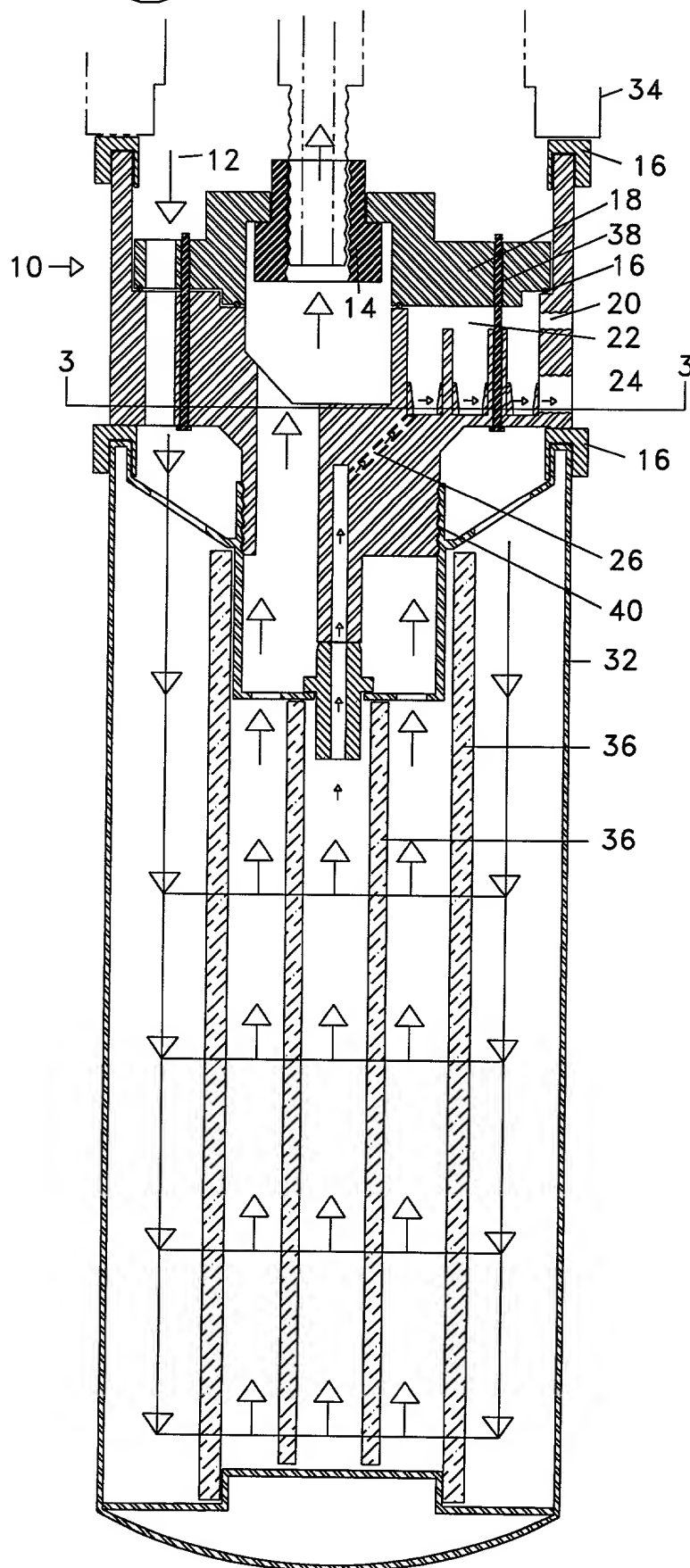


Fig 11



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Fig 12

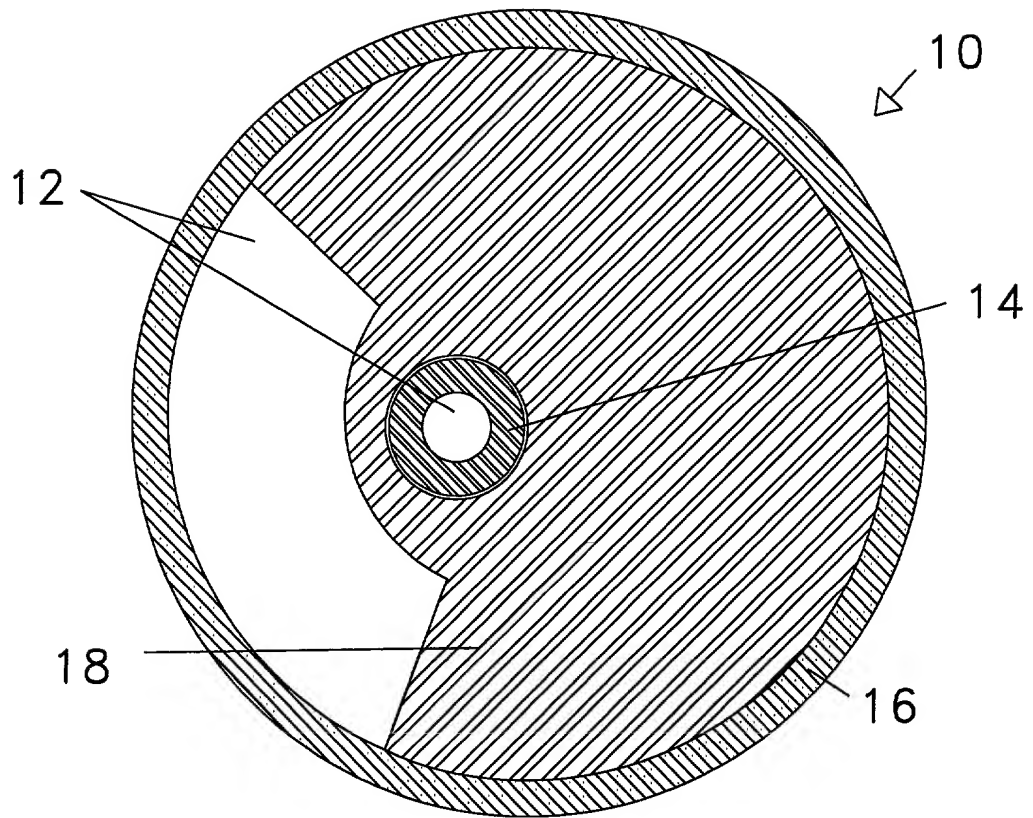


Fig 13

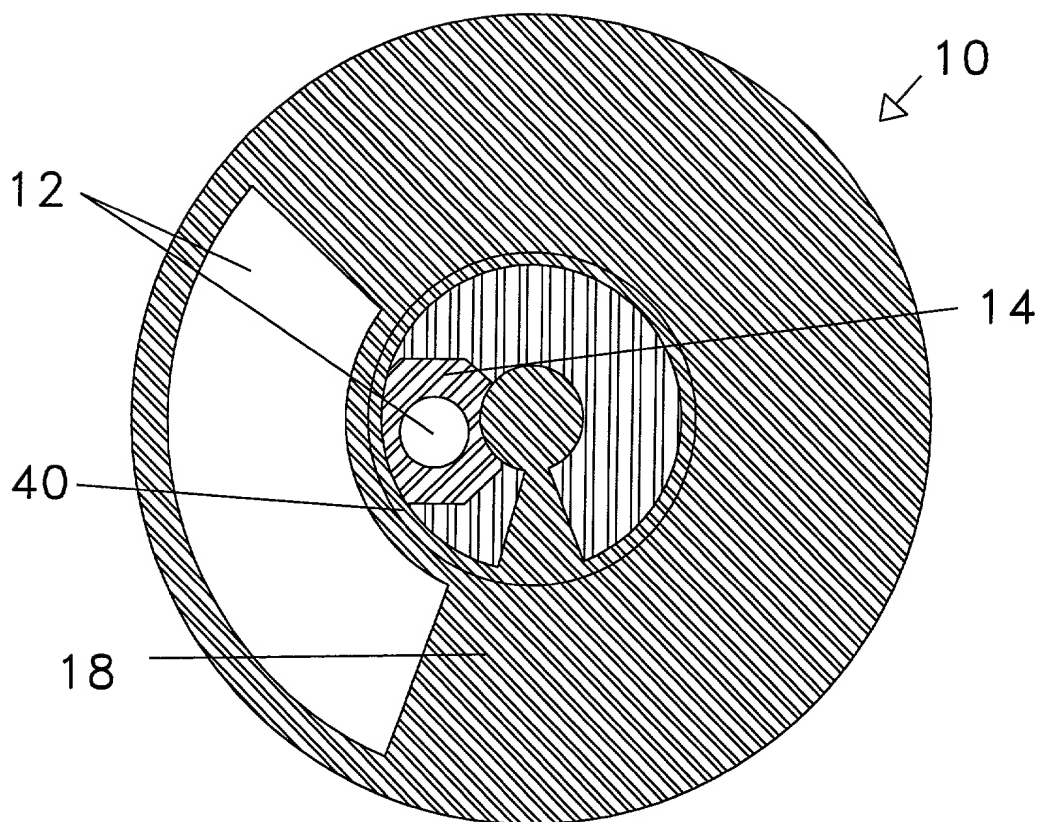


Fig 14

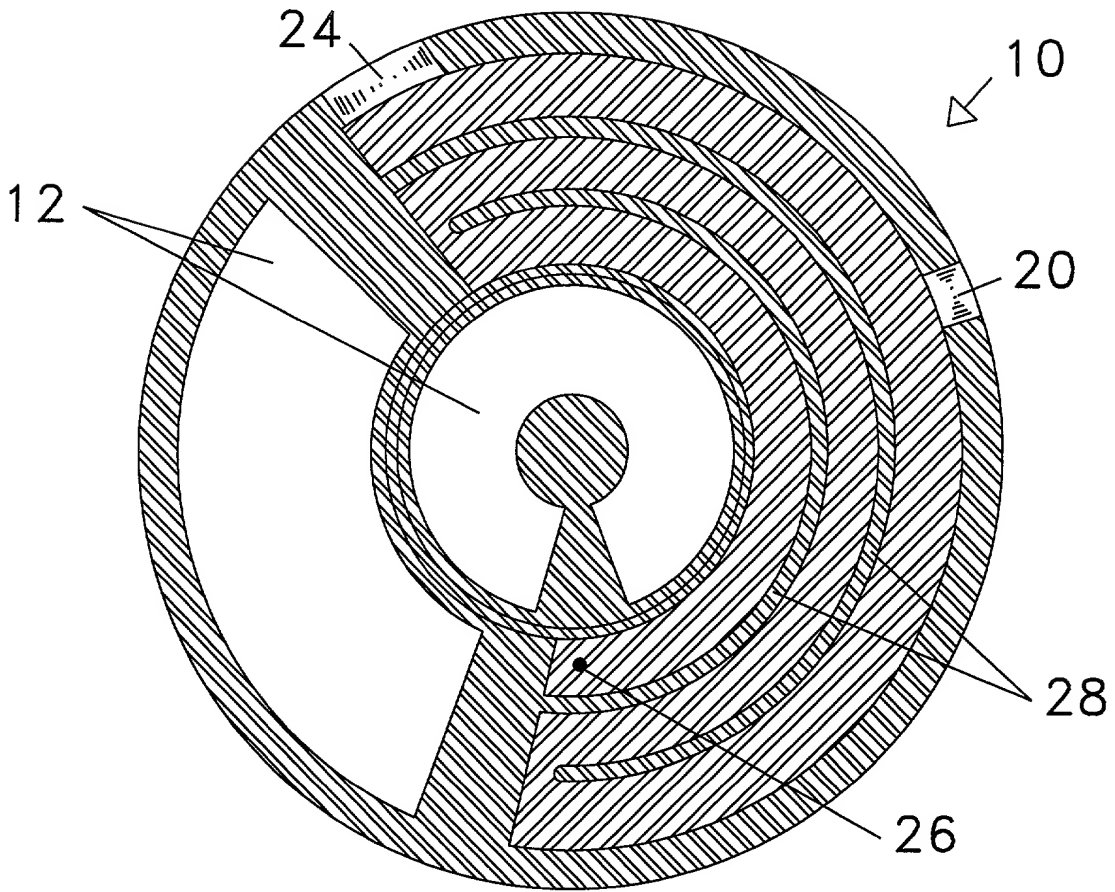


Fig 15

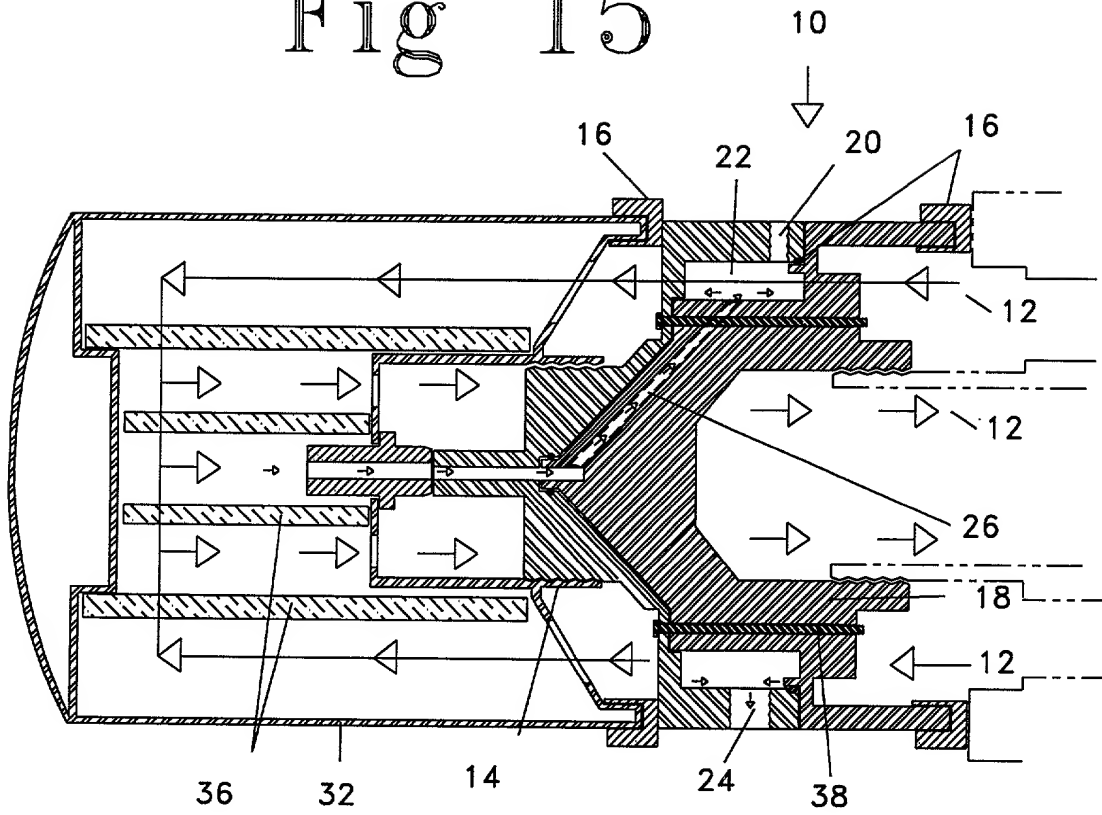


Fig 16

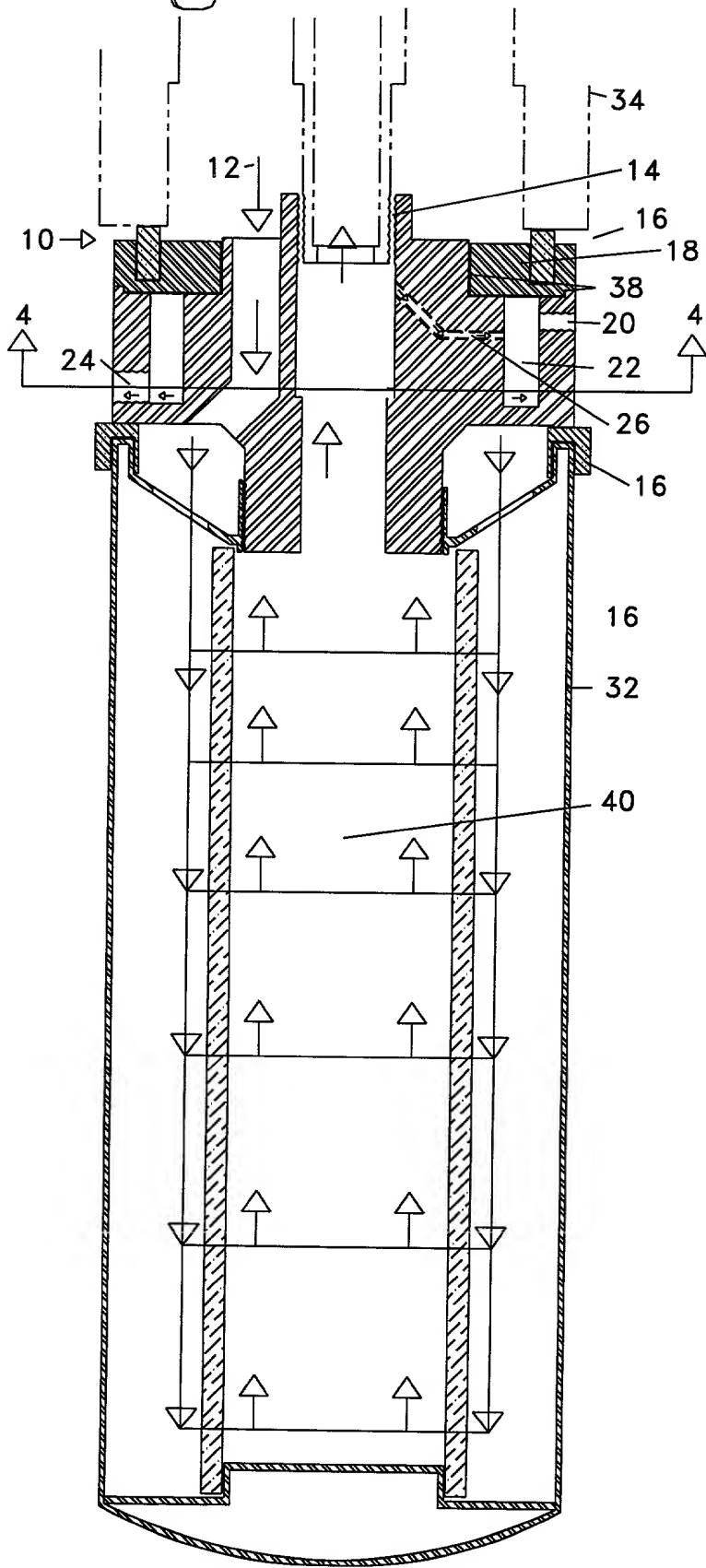


Fig 17

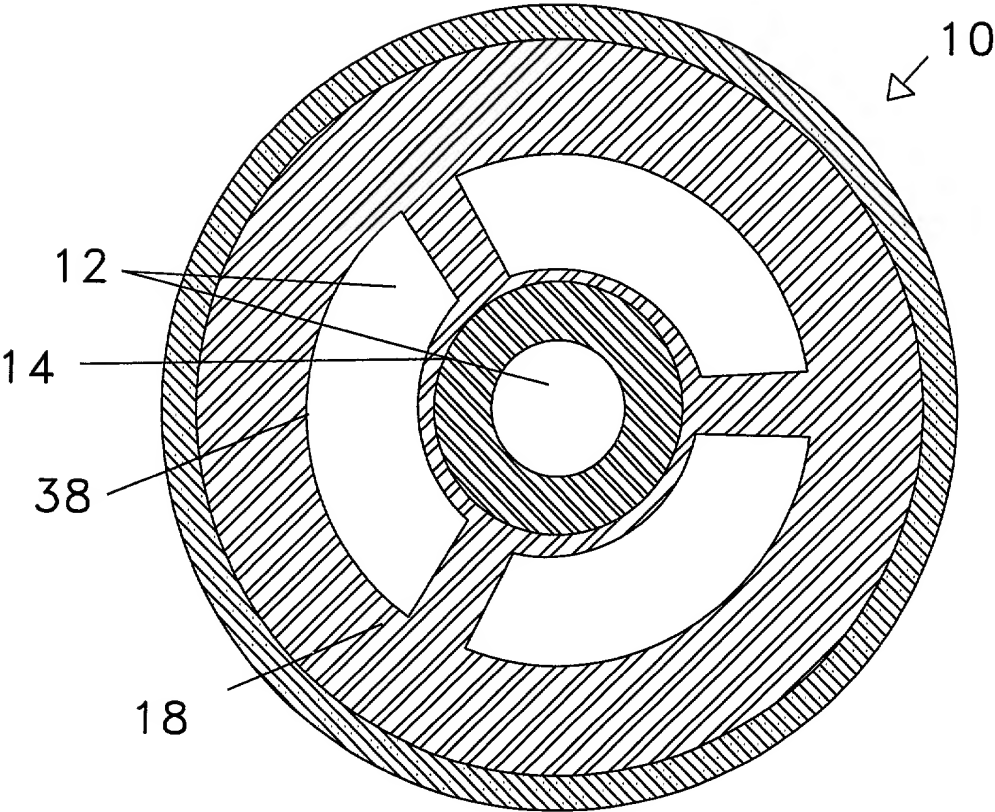


Fig 18

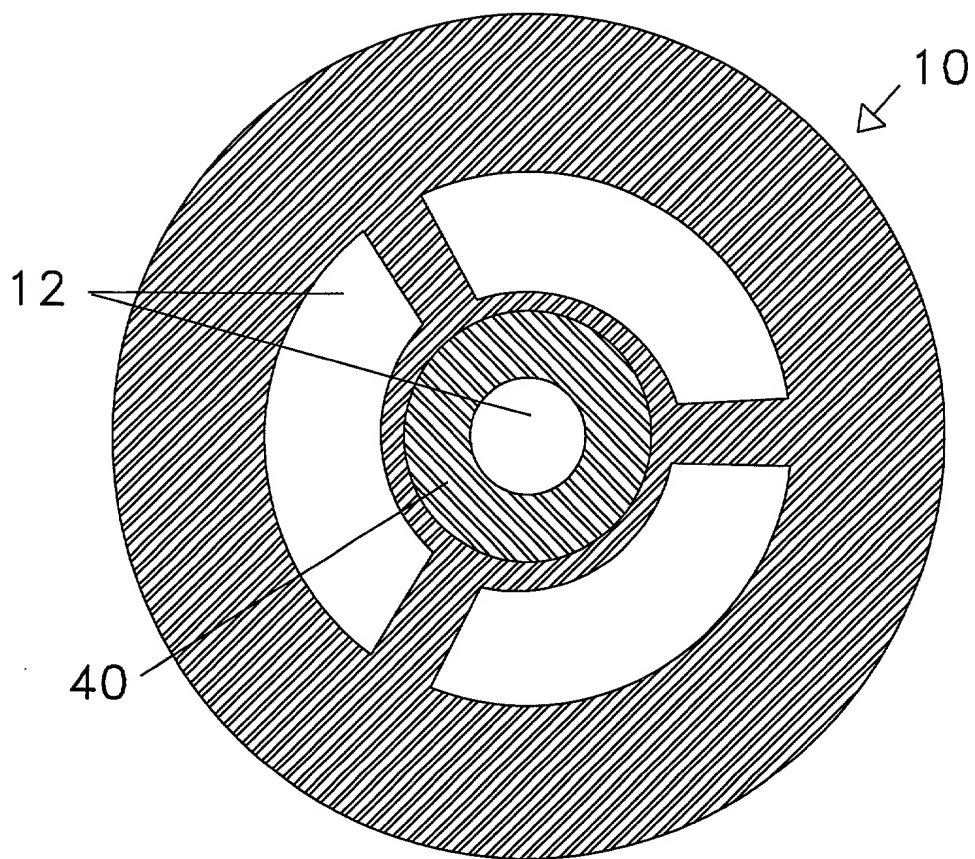


Fig 19

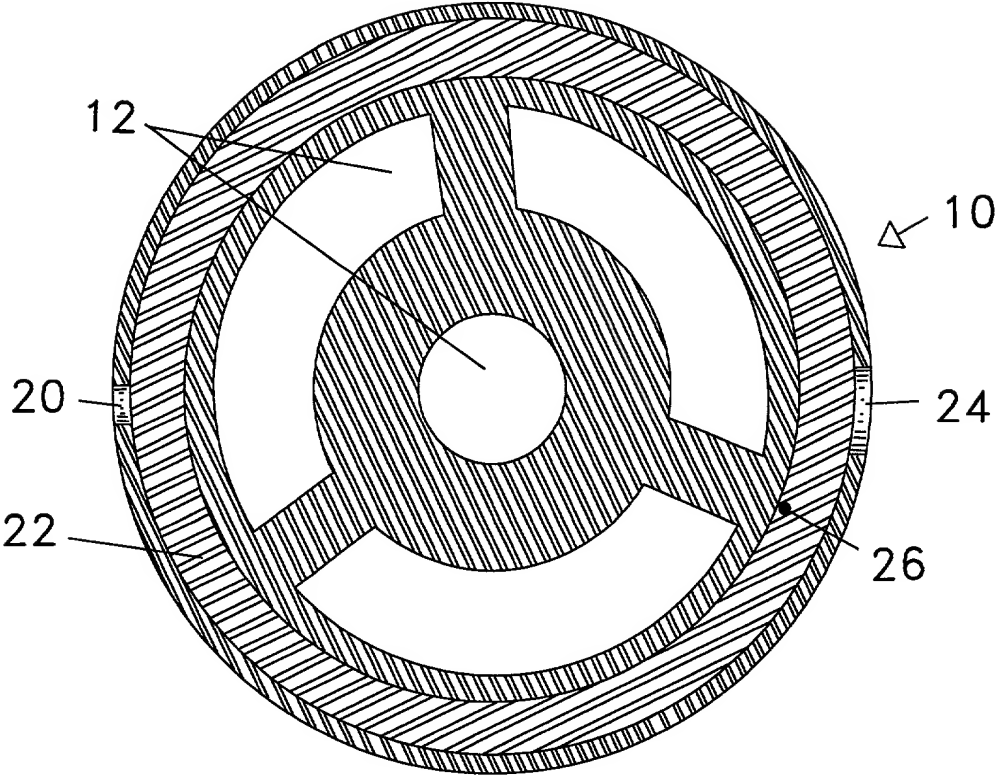
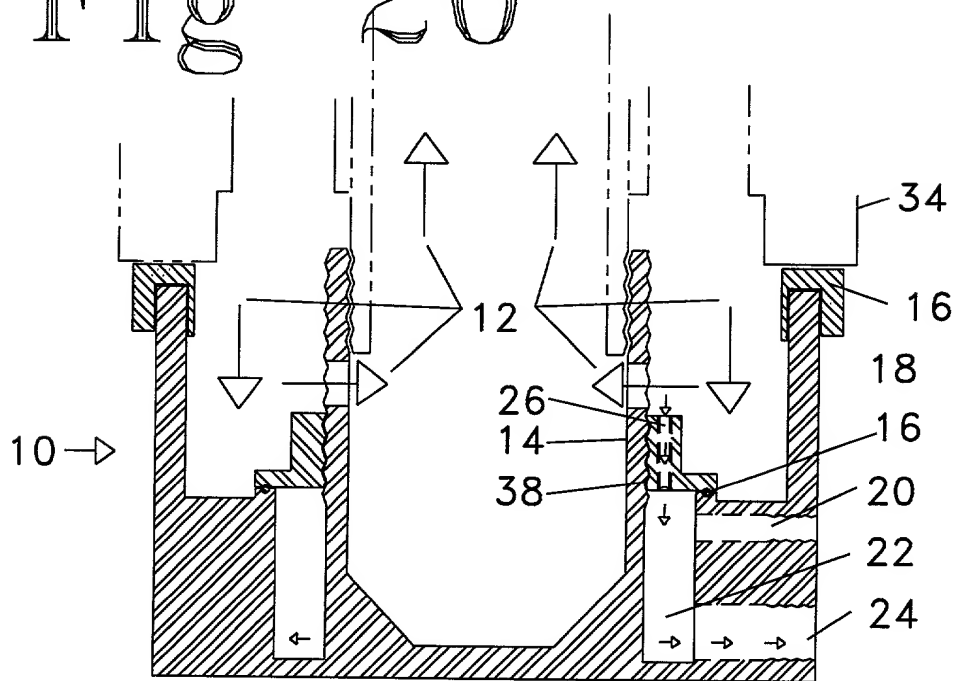


Fig 20



Declaration for Utility or Design Patent Application

As a below-named inventor, I hereby declare that my residence, post office address, and citizenship are as stated below next to my name and that I believe that I am the original, first, and sole inventor [if only one name is listed below] or an original, first, and joint inventor [if plural names are listed below] of the subject matter which is claimed and for which a patent is sought on the invention, the specification of which is attached hereto and which has the following title:

" Liquid purifying device "

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration. I acknowledge a duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, Section 1001, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Please send correspondence and make telephone calls to the First inventor below.

Signature: Sole/First Inventor: Charles Andrew Lowry

Print Name: Charles Andrew Lowry Date: July 19, 2000

Legal Residence: * 770 East Vine St. # B, SLC. UT 84107 Citizen of: USA

Post Office Address: 770 East Vine St. # B. Salt Lake City.
UT 84107

Telephone: 801 685-7257

Signature: Joint/Second Inventor: _____

Print Name: _____ Date: _____

Legal Residence: * _____ Citizen of: _____

Post Office Address: _____

Telephone: _____

* City and state, county and state or city, state and country, if foreign.